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Proceedings of the Maritimes Regional Advisory Process of the Eastern Scotian Shelf Snow Crab

23-24 March 2004
Mic Mac Amateur Aquatic Club
Dartmouth, Nova Scotia

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Compte rendu du Processus consultatif régional des Maritimes concernant le crabe des neiges de l'est du plateau néo-écossais

du 23 au 24 mars 2004
Mic Mac Amateur Aquatic Club
Dartmouth, (Nouvelle-Écosse)

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Canada

FOREWORD

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or mis-leading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached.

AVANT-PROPOS

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s'est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

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ABSTRACT

These proceedings record discussions that were held during the Regional Advisory Process (RAP) meetings for Scotian Shelf Snow Crab stocks in Maritimes Region on March 23-24, 2004 The scientific peer review of Eastern Nova Scotia Snow Crab (Areas 20-24) was conducted. The discussions from this meeting are presented in this document.

RÉSUMÉ

Le présent compte rendu relate les discussions tenues pendant les réunions du Processus consultatif régional (PCR) portant sur les stocks de crabe des neiges du plateau néo-écossais, dans la Région des Maritimes, les 23 et 24 mars 2004. Lors de ces réunions, on a procédé à un examen scientifique par les pairs de l'état des stocks de crabe des neiges de l'est de la Nouvelle-Écosse (Zones 20-24); les discussions auxquelles il a donné lieu sont présentées ici.

INTRODUCTION

The meetings were held the Mic Mac Amateur Aquatic Club, Dartmouth, 23-24 March, 2004. The Invitation letter and list of Invitees are in Appendices 1 and 2. The Chairman, René Lavoie, welcomed the participants (Appendix 3), explained the procedure for the meeting, the specific role of scientific referees, industry representatives and observers, and reviewed the agenda (Appendix 4).

The Chairman explained that the objective of the meeting was to conduct a thorough peer review of the stock assessments presented by biologist-in-charge Michel Biron with input from representatives of the province of Nova Scotia and from the industry. He also clarified that the RAP was NOT the place to discuss management considerations. The Remit for this meeting is in Appendix 5.

In these proceedings, summaries of presentations and comments from referees are the work of the authors and have been reproduced with little or no editing.

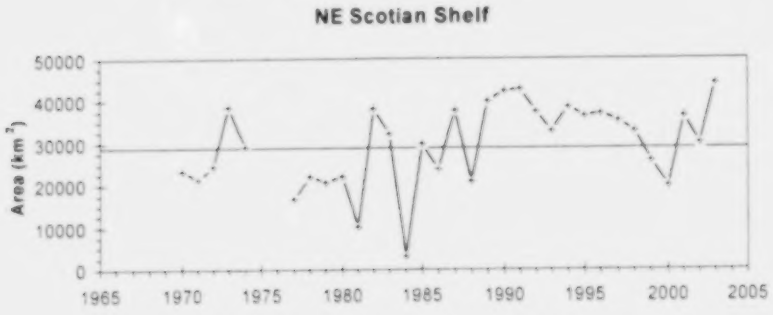
SUMMARY OF PRESENTATIONS
Q&As and Information Papers

Ecosystem Considerations
Dr Joël Chassé

Cold bottom temperatures (<4°C) typically exist year-round in the deeper area northeast of French, Middle and Banquereau Banks (CFAs 20 to 23, with 24A and 24B), as well as in a narrow band along the shore (24C and E) that ends in southwestern Nova Scotia (4X fishery). At the time of the trawl surveys in 2003, the coldest bottom temperatures (less than 1°C) were found over Misaine and Canso banks. Temperatures gradually increased from these regions to 3°-5°C towards the east in Laurentian Channel and to 3°-4°C on the shallow areas of Banquereau and Middle Banks to the south and west. Bottom temperatures in the vicinity of Sable Island were around 5°-7°C. The warmest temperatures in 2003 (7° to greater than 9°C) were in the southwestern portion of CFA 24 (Emerald Basin, Emerald Bank and Western Bank). Although colder in 2003, this spatial pattern in near-bottom temperatures is typical of that seen in most years.

Bottom temperatures in the northeastern Scotian Shelf were typically warmer-than-average during the late'-1970s and early 1980s. In the mid-1980s they declined reaching a minimum in the early 1990s. Temperatures then rose gradually until 1999 when they reached above average values for the first time since the mid-1980s. Temperatures continued to rise through to 2000 but dropped below average in 2001 and rose again above the mean in 2002. During 2003, temperatures were significantly colder than the long-term average (1971-2000) having cooled relative to observation in 2002. On the Northeastern Scotian Shelf, the snow crab habitat index, defined by the area of the bottom with temperatures of -1° to 3°C, increased to above average and represents the highest value of the timeseries. The average temperature within the habitat is at its lowest point (1.14 °C). Although not as extreme, similar conditions were present in the Sydney Bight area. This is consistent with the observed colder temperatures in 2003. Given that colder conditions in these regions are considered to be advantageous for snow crab, the higher snow crab habitat index and the below-average bottom temperatures indicate that bottom conditions were significantly more favorable for the adult snow crab in 2003 compared to conditions observed during 2002.

Snow Crab Habitat Index



Discussion

John Tremblay
Q: Do large scale climate indicators suggest that these temperatures will continue in the future?
A: When temperatures are cooler, they usually stay in this stage for a couple of years, but it is hard to predict the future. It is not clear if there will be an increase or decrease in future temperatures.

Russell McLellan
Q: Do the melting ice caps have an influence on the water temperatures on the Scotian shelf?
A: No, not the whole Scotian shelf because of what happens before ice formation. There would be a local effect on the salinity at the surface of the water.

Marc Lanteigne
Q: Are there slight differences in temperature in areas 23 and 24 caused by the bathymetry?
A: Yes, basically.

Gordon MacDonald
Q: We normally fish at depths of 200m. Fishing was not good in the normal holes this year. Do the temperature anomalies cause temperatures at 200m to be equal to last years temperatures at 100m? Is it why we see less crabs in deeper parts and more in shallow parts?
A: Possibly. I did not analyze if the habitat of the crab was more favorite in the deeper part or in the shallower part of the Scotian shelf. There could be a local migration due to better habitat elsewhere.

Glace Bay Hole Experiment
Michel Biron

The objective of this project was to establish the distribution, biomass and other biological parameters of the snow crab population over a large area of soft and hard bottom by means of simultaneous trawl, video camera and trap surveys.

The experiment vindicated the wisdom of moving the annual trawl survey in 2002 from Spring to fall to avoid the seasonal movement in Winter and early Spring towards the shallower and colder bottom of the banks to molt and mate.

General conclusions that can be drawn from the experiment are : 1) overall trend calculated for N-ENS are apparently representative of the stock since the survey covers the highest density grounds; 2) excluding the surface of the bank from kriging has produced an overly conservative biomass index; 3) the seemingly resilience of N-ENS to the current harvesting level might have been caused by a limited concentration of snow crab unaccounted for and located in the untrawlable perimeter of the surveyed area; 4) inter-annual fluctuation in bottom temperature at the time of the survey may affect to a certain degree the magnitude of any perceived fluctuation in the population by affecting the distribution of snow crab between trawlable and untrawlable grounds.

Discussion

Andrew Cooper
Q: There seems to be a shift in time and the catchability of R-1 crabs. What drives this difference in catchability? Are there few adult males? Is it related to the timing of the molt and soft-shelled crab? Are they the same R-1 crabs between June and October?
A: R-1 crabs move to the banks to molt and to mate. This is temperature driven. The number of R-1's increase in the fall, therefore they are coming down (from the banks) later in the year.

David Orr
Q: Can you do a comparative study of gear types and their selectivity?
A: We are planning to do that this summer. We will look at different bottom types and the effects it has on catchability and selectivity. We will use the video camera as part of this project.

Marc Lanteigne
Q: How many crabs were counted with the video survey and with the trawl survey?
A: About the same amount, 400.

Neil MacMullin
Q: Are the crabs in shallower water during the fishery?
A: The trawl works better later in the year. There is better catchability.

Q: The survey results were comparable, why?
A: Temperature does play a role in the distribution.

Q: Could we miss recruitment between seasons?
A: Yes! Timing is important.

Q: Only a 1˚C temperature difference in GBH, but there was a big difference in catch.
A: Yes. They will stay in colder water as long as they can.

David Rambeau
Q: Is it possible that recruitment was missed because the temperature stayed low longer in the hard bottom, shallower areas?
A: Possible. It would have been better in the fall.

Q: Are the temperature changes the same on other banks as in GBH?
A: It is not possible to make this assumption.

Q: What does conservative estimate mean?

A: We found there were crabs outside the trawling bottom area, so estimates have been conservative.

Philip Nash
Q: Are you confident enough to eliminate the trap survey for the video survey?
A: No, because this was the first year for this project. It needs to be done at least 3 years in order to become scientific.
(Mikio Moriyasu) It is because of Philip Nash's intervention that we did this survey. This is a good start. In GBH the estimates are conservative. This is not a total biomass. The video and trawl surveys will enhance the precision of the stock assessment.

Bob Anderson
Q: Why do crabs go to colder water?
A: Crabs move to shallower colder water to mate and molt. The temperature stayed colder longer on the banks this past year meaning the mating period might have been longer. Depths of 15 fathoms are extraordinary, but they did come on the banks.

Mike Eagles
Q: Are the June and October biomass estimates adjusted for the fishery?
A: No, they just reflect what saw in the survey.

Modelling Uncertainties
Elmer Wade

The presentation on "Modeling uncertainties" dealt with several issues regarding some of the necessary parameters needed to develop a workable model used in projecting short-term population estimates. The loss parameter, which describes the bias shown between population estimates made a year t versus the sum of the residual population along with the catch at year t+1 was calculated for both the northern and southern ENS snow crab zones. A large variability exists in this parameter estimation. Projections of recruitment to the fishery were also made using relationships between observed immature populations of various sizes and observed recruitment in subsequent years. Recruitment is not expected to increase significantly in these zones in the short term from these analyses. This translates therefore in a projected decrease in biomass in the coming years. It was shown that under this situation of reduced recruitment that a more conservative exploitation strategy in the short will mean more available biomass in three years compared to a sustained high exploitation regime.

Discussion

Stephen Smith
Q: Loss and Recruitment converging? This seems strange.
A: There is a leveling off of catch, I do not know if they would converge. Loss equals natural mortality.

Bob Anderson
Q: Are discards included in the calculation of natural mortality?
A: It may show up over the years if there is a lot of mortality due to discards.

Q: In Newfoundland, they underestimated this number. It is very important to know. Is there a percentage in the SGSL to account for this?
A: Attempts were made to account for this. Mikio knows the numbers better.

(Michel Biron) During the spring surveys, mortality was calculated from the observer data, but now that the survey is in the fall, this is not necessary and it has been abandoned.

Q: We need to obtain consistency in the timing of the trawl surveys.
A: In certain years, the catch component some years occurred before the survey and some years after the survey. The model is different depending on the year you look at, but you are right, it is important to consider the analogy for calculation of abundance.

David Orr
C: As the catch rate goes down, the fishermen work harder to catch the quota. Therefore, they end up in catching more soft crabs meaning they would kill more crabs due to discards. I think this number will create a bias in your data.

Q: Are there comparisons between the changes in boats and timing of the surveys?
A: No comparisons or adjustments have been made. The same gear and net sensors have been used. We do not believe the area swept has changed with the boats.

Bruce Osborne
Q: The quality of the crab is important to buyers. There was a change in carapace condition from 2002 to 2003. Have you looked at the aging factor and made any projections?
A: No, no attempt to more precise projections was made.
(Mikio Moriyasu) Estimate of mortality is a new tool. This is only the second year. The purpose is to know the long term fluctuation of biomass. Mortality is calculated of the lump sum group of commercial sized males. The category 2, 3, 4, and 5 should not be the same. We need an absolute aging of crab and epibiont distribution and the geologic difference of carapace conditions. For example, the same age crab from Chedabucto Bay will have different epibionts than one from Sable. We are not ready to include this in the stock assessment.

Paul Kehoe
Q: Do you account for mortality caused by other fisheries such as shrimp draggers?
A: No. We use observations from one year to the following year.

(Mikio Moriyasu) Elmer is not looking for who killed the crab. We would have to do a separate study to know who killed the crab, for example, the shrimp fishery. We know that there is a loss, but we do not know what causes the loss. This is a different issue. You are asking to know the effect of other fisheries on the snow crab fishery.

Mike Eagles
Q: Your mortality was much higher in 1990. Your biomass estimates were different. As mortality decreased in time due to science?
A: Michel Biron changed the masks to be more consistent with previous years.

Herb Nash
Q: With a mask of zero values, are we missing R-2 and R-3 in the evaluation with a depth less than 90m?
A: For assessment purposes, we put the zeros on the banks. In recent years, crabs have been found on the banks, but there does not appear to be a large recruitment. Banks do not come into play with length and frequency distributions.

Q: Fishermen have been catching small crab in their lobster traps set in 15-18 feet of water. The small crabs are in shallow water. There should be a survey there.

A: Michel Biron will discuss changes in surveyed area. There are points on the banks.

David Rambeau
Q: The impulse of small snow crab in area 20-22 will take 4-7 years to enter the fishery if they do in fact enter it?
A: Yes.

Q: With your pre-recruit histograms, are you suggesting the end of the snow crab fisheries?
A: We showed this graph because we want to make sure you can see there will be a lower recruitment and we should be careful with the fishery.

Update on Modeling the Drift, Growth and Survival of the Early Life Stages of Snow Crab in the Gulf of St. Lawrence and Scotian Shelf
Dr Joël Chassé

A bio-physical semi-lagrangian model is used to better understand the drift, growth and survival of the snow crab larvae in the Southern Gulf of St. Lawrence and Scotian Shelf. The modeling system is composed of Individual-Based Models (IBM) of snow crab larvae coupled to a full 3-D hydrodynamic model of the ocean. The physical model is forced by tides, winds, heat fluxes and inflows at open boundaries. All of the data required to force the model from 1950 to 2003 has been collected. The main biological input to the model is the parameterization of the distribution and abundance of the snow crab mature female in the Southern Gulf and Scotian Shelf as well as growth and mortality rates.

Results of the simulations (1991-2003), show large scale drifts and exportation of snow crab larvae from the southern Gulf of St. Lawrence to the Scotian shelf before settlement at the bottom. This exportation from the Gulf is correlated with variations of the wind field. Some larvae, released on the Scotian (fishing areas 23-24), are advected south-westward but the modeling system clearly show some retention in the area of Misaine Bank and Banquerau Bank. A more quantitative approach needs to be taken to determine the ratio of retention into areas 23-24 to the importation from the Southern Gulf.

Fred Kennedy
Q: What is the time frame in your July map?
A: This is a model that is not completed because of CPU timeouts, but larval settlement goes on until august.

Q: Does the settlement start as we begin our fishing season?
A: Yes because the water gets warmer and it is profitable for larval growth.

Q: What is the percentage? Are they all settling out at the same time? If females release and 100% is released, when does it happen? May?
A: That is what Mikio believes happens in the SGSL. It could be a little different in ENS. (Mikio Moriyasu) There are no black eggs after May.

Q: A seismic project is planned for this summer or around May. Do they stay around for 60 days or 90 days?
A: 60 days.

Q: The larvae are in the first 5m of water and there are 4 stages?
A: Yes, but the first stage is the prezoeae stage and it only lasts about one day.

Q: The larvae stages happen all in the water column?
A: The first two stages are in the surface layer. Megalops are closer to the bottom. (Mikio Moriyasu) The first stage likes light, the second has less preference for light, and megalops hate light.

John Tremblay
Q: What are the major uncertainties that this model projects? What is the vertical distribution of the snow crab larvae?
A: About the quality of the results, I am confident with the Gulf data. For the Scotian shelf I am not too comfortable with the physical aspects of the matter, but I am quite confident I have the main features. Growth rate and food limitation could be a factor. The length of the megalop stage is 2 to 3 weeks. This needs more study. It could vary in ENS. (Mikio Moriyasu) At the mouth of a river doing vertical migration, some species have the capacity to maintain their position. This is not looked at in the model.

Paul Kehoe
Q: Is ice flow taken into consideration?
A: No, because the larval drift start in the month of May where the ice flows easily with less friction with the surface water.

Q: It couldn't move the larvae in a different direction?
A: This is the area where we find females (Area 24E)

Q: Are there males in the untrawlable area in Area 4X?
A: The ice wouldn't affect them in May, but rather in the winter. Ice only affects the current in the winter.

SUMMARY OF WORKING DOCUMENT

Biron, M., L. Savoie, C. Sabean, E. Wade, M. Hébert, and M. Moriyasu, 2003. Historical review (1996–2002) and assessment of the 2003 snow crab (*Chionoecetes opilio*) fishery off eastern Nova Scotia (Areas 20 to24). CSAS Res. Doc. 2003/05 92p.

The assessment of the snow crab stock status for eastern Nova Scotia in 2003 is presented based on the 1996 – 2003 fisheries data (logbook and sea sampling of the commercial catches) and 1997 – 2003 trawl surveys. A new spatial analysis of the landings from 1997 to 2003 is introduced in this assessment. Minor changes were made to the computation steps used to develop mapping and abundance estimations that have rescaled the survey series relative to the mapping and abundance estimates of 2003.

Landings in ENS have been at record levels (>10,000 t) since 2000, but signs of decline of the adult population are now becoming apparent. Fishery, at-sea observer and trawl survey indicators point to a declining commercial biomass. Considering that the estimated abundance of recruits at low levels for the past 2-3 years and the indication that the abundance of crab expected to recruit in 2-3 years will also stay at low levels. It is likely that the abundance of the resource will continue to decline for a few more years. However, the presence of small crab (15-50 mm) suggests that recruitment may improve after the anticipated period of lower abundance.

COMMENTS FROM SCIENTIFIC REFEREES
GENERAL DISCUSSION
Stephen Smith, David Orr, Andrew Cooper, and Marc Lanteigne

Stephen J. Smith
Invertebrate Fisheries Division
Bedford Institute of Oceanography
Dartmouth, Nova Scotia

General Comments

The document is highly complex and as a result very difficult to read. Details on the methods, results and interpretation are spread throughout the document. Given the many different data sources presented here, it would be more helpful to the reader to have methods, results and interpretations altogether in one place. There are a large number of grammatical mistakes that will need to be corrected.

Specific Comments

Annual Trawl Survey:

"Masks" labelled as 1997–2000 and 2001–2003 are presented in Figure 4 and briefly introduced on pages 5 and 6. These masks are used to delineate areas of potential crab habitat for the kriging estimates from the surveys. Were these masks used to calculate annual biomass estimates for the two areas (N-ENS and S-ENS)? If so, which ones and for what years? My confusion stems from the boundaries displayed in Figures 30 to 35 and Figures 37 to 42. In the first set of figures representing the survey in N-ENS, the same boundaries seem to be used for all size classes and years and this set of boundaries correspond to those in from the top panel of Figure 4 (1997–2000). The figures for S-ENS surveys appear to use the 2001–2003 mask for the 2003 survey for all size classes and for the complete time series for adult males carapace conditions 1, 2 (Fig. 39) and 3,4 and 5 (Fig. 40). It appears that the 1997–2000 mask or some variation of it was used for all the other years and size classes.

Changes to the survey area are noted in the Introduction, where it is stated that changes made to the mapping and abundance estimation in 2002 and 2003 resulted in rescaling the survey series relative to the abundance estimates in 2003. On page 5, the text states that in the past overall survey trends were reported based on the original surface surveyed in 1997 in S-ENS and in1998 for N-ENS. Survey estimates for N-ENS are presented on page 16 and in Figures 24 and 25. Are these scaled to the area covered in 2003 or 1998?

For S-ENS, the biomass index for commercial size males has been rescaled to the surface surveyed in 2003 according to the test on page 17. However, biomass estimates given in the text and Figure 43 were apparently calculated for the original area surveyed (1997). What survey area were the estimates of female crabs in Figure 26 based on?

On page 10, the text states that kriging was based upon analyzing and modelling the covariance between sampling units as a function of the distance between them. Sampling units are therefore tow stations. However, further down in the paragraph it is stated that "Separate variograms and density estimates were calculated for each sampling unit.". If that is true then sampling units are not tow stations or this statement is incorrect.

At the top of page 11, there is a description of the projected biomass index procedure. A tabular display of the estimates would be helpful to assess this procedure but it appears that the results of this projection method were never used in the document.

Where did the criterion of 1000 crabs/km^2 on page 11 come from? Was this 1000 commercial size males or a total of all crabs?

In the Discussion section (page 25) it is claimed that the estimate of biomass is based on the assumption of 100% catchability of commercial size crabs. Obviously whether or not this assumption holds would determine if the biomass estimate was an absolute or relative estimate of biomass. The estimate itself does not require this assumption, only in how one uses the estimate is the assumption important. Catchability may also be a function of time of year the survey is conducted, the type of gear (doors, etc.) and how the gear performed as monitored by NetMind or Scanmar.

The survey series has suffered from changes in vessels, areas covered, gear used and timing. Given that the timing change (spring to fall) was made to avoid seasonal movements what changes were anticipated in the survey estimates from this change assuming nothing else had changed? What changes could be expected from the three month delay of the S-ENS survey in 2003?

Spatial Analysis:

The procedure for conducting the spatial analysis of the landings data states that grids are ordered by increasing catch and the number of grids that account for 95% of the catch is counted up (page 7). It is not clear if the counting starts from those with the smallest catch as implied by the requirement to order grids by increasing catch or by starting with the grids with the largest catch. The latter approach would be the preferred one given the type of analysis being conducted here. Apparently, this analysis was determined to be not useful as it was not mentioned in the Discussion section, although it was presented in the Traffic Light table.

Miscellaneous:

On page 15, the text states that the discrepancy between the reported landings and TAC in CFA 23 in 2003 was partly due to reported landings by 2 permanent licence holders. What does this mean exactly? Were these reports too late to avoid over-running the TAC?

Traffic Light Table:

How can there be red indicators for Pre-recruits and recruitment in N-ENS and S-ENS when no limit was defined for this colour in Appendix 2? Using simple year-to-year changes for CPUE (or Areal index, Abundance index) will make the index very sensitive to annual variation. Is there an economic lower limit for CPUE for fishermen? Based on experience in the Gulf of St. Lawrence, can a lower limit (red) be suggested? Using increase and decrease of temperature from year-to-year also suffers from sensitivity to annual variation.

Slope Surveys:

The conclusion in subsection 5.1.2 regarding the pulse of recruitment in CFA 24 seems stronger than the supporting text on page 22 where it states that it is premature to make any conclusions.

Basis for TAC:

It is never explicitly stated in the document what the bases are for the TACs in the two areas. The authors note that from 1994 to 1997 that TACs, IBQs or fleet caps were based on "recent landings history" rather than on scientific surveys. From 1999 onwards, scientific surveys were available and TACs were increased. How were the survey estimates translated into TAC increases? Is there a target exploitation rate or some other target for this fishery? How can we use the surveys to set TACs for 2004/2005?

How long will it take for the 15–50 mm crab to grow to commercial size?

David Orr
Northwest Atlantic Fisheries Centre
St. John's, Newfoundland

It is obvious from the document that a great deal of hard work and dedication went into the research, analysis, assessment and preparation; however, the document should be thoroughly edited to correct potential errors (grammatical and otherwise) as described below.

In the first sentence of the document, the authors indicate that figure 1 illustrates how the snow crab fisheries evolved off the coast of eastern Nova Scotia. However, rather than illustrating evolution, figures 1 a) and b) indicate the Crab Fishing Areas (CFAs) and important areas described in the document. Possibly figure 53 better illustrates the evolution of the CMAs.

On page 5, why are Vessel Monitoring Systems (VMS) required for CFA 23 permanent licence holders that "choose to start fishing in June"? Why isn't VMS required for all licence holders?

The document (page 5, Section 1.2 Evolution of the trawl surveys) indicates that since 1997 the survey has changed from a pre-fishery spring survey to a post-fishery autumn survey, it has made use of four vessels over the seven year period and the area surveyed has changed. Table 2 also indicates that there have been several changes in the timing of the survey. Changes in survey design and vessel are sometime necessary; however, for inter-annual comparisons it is suggested that the survey area be fixed, that it be restricted to a limited time period each fall (i.e., Oct. – Nov.) and that a protocol be developed to ensure consistency of data between vessels.

As part of the annual trawl and trap surveys, you collect data on the "presence and color of eggs" would it also be possible to collect clutch fullness information? Pathology such as bitter crab disease should also be monitored.

I am concerned that the index of abundance (page 8, Section 2.1.3 Commercial snow crab availability (abundance index)) total landings divided by the number of grids necessary to account for 95% of the catch) could be confounded by changes in management plan and fishing patterns. Figure 53 indicates that the CMAs were changed numerous times over the

years. It is possible that area fished could be decreasing within each CMA, but if at the same time the number of CMAs were increased then the index of abundance could potentially give the wrong impression that the abundance is increasing.

The number of grids required to obtain 95% of the catch within the fall survey can be used to provide an index of abundance because the stations are fixed. Such an index would be redundant since the survey is already being used in kriging. The amount of area accounting for 95 % of the fall survey catch should be compared with the spatial index from fishery. The survey spatial index could also be compared with the commercial CPUE. Does the area fished increase as CPUE decreases?

At the bottom of page 8 and the top of page 9 the authors indicate that "For port sampling, a sub-sample of 20 crabs was sampled at random after a fisherman had sorted the catch". Please indicate why and how the fishermen sort the catches. Are any of these animals discarded after sorting? This could be an important source of mortality. Does sorting change from year to year due to market demands? How does sorting influence your data?

What is the gear selectivity of the Bigouden Nephrops trawl? Can gear selectivity experiments be used to standardize survey catches and thereby improve the abundance/ biomass estimates?

Please provide a legend for the circles and squares in figure 5.

At the bottom of page 14 (section 3.2.3 At-sea sampling by observers) the authors note that a total of 115 traps were sampled at sea, corresponding to 0.59% of the total number of trap hauls. Was there an analysis to determine whether the samples were representative of the catch? How many trips were observed? By quickly comparing the logbook positions (figs. 6 and 14) with the observed positions (fig. 8) it appears observer locations were spatially representative of the fishery. The fishery is finished with a matter of weeks therefore the observer data was probably temporally representative. A comparison between the observer and port sampling may indicate whether there were any biases.

Section 3.2.3 discusses a comparison between 2002 and 2003 catch compositions and notes that figure 11 illustrates these changes. Figure 11 illustrates an inter-area rather than an inter-annual comparison of catch compositions. A correction should be made.

The assessment should make use of discard data from the observer program. Discards could be an important source of mortality especially if CPUE, biomass and abundance indices are in decline while landings are being maintained.

A legend should be provided for figure 12. What do yellow and grey squares represent? Do the yellow squares indicate the grids from which 95% of the catch was taken?

An editorial correction should be within 3.3.2. At the end of the fifth sentence, the authors state that there was a marked increase in CFA 24 C CPUE; however, the increase was in CFA 24 D CPUE (see fig. 16).

Does the Nephrops trawl capture small crab (15-50 mm) well, or is the high abundance of small crab in Northeastern Nova Scotia (figure 27) random chance?

3.6.2 South-eastern Nova Scotia. Figure 36 does not indicate that the density of adolescents decreased in 2003 compared to 2002. Figure 36 is simply a series of length frequency plots.

The authors should refer to figure 37 which is a set of density plots. The document usually makes comparisons between 2002 and 2003. It should be modified to indicate when trends actually began. In this case, density began to decrease during 1998.

Following the biomass indices the authors present ranges within square brackets. Are these standard errors or 95% confidence intervals around individual indices? Could the biomass estimates be checked between the Glace Bay Hole pre-season trawl survey and the video survey, both have a biomass estimate of 1,297 t [605 – 1989 t] (page 18 for the trawl survey and 19 for the video survey)?

I notice that there was only a five station overlap between the Glace Bay Hole trawl survey and the video survey. In the future could there be more of an overlap such that various habitats (temperature, substrate etc.) are covered by the trap, video and trawl survey. This would allow for a calibration of the various techniques and hopefully would allow one to develop habitat specific correction factors thus improve the biomass/ abundance estimates.

Why didn't the authors derive exploitation indices?

Discussion

4.1 The Fishery

In general, the authors should consider using one standard error around the long term arithmetic mean of the CPUE, biomass/ abundance indices in order to objectively determine whether indices are increasing, decreasing or stable. Otherwise it is not clear whether a -3% change in an index is a real decrease or noise. This could potentially be used to set colors within the traffic lights. One standard error on either side of the long term mean could be yellow; two standard errors above the long term mean could be green for an index such as biomass/ abundance CPUE etc., whereas two standard errors below the long term mean would be red.

I think that they are correct, it may be time to start think about standardizing the CPUE, but be aware that it will never be perfect and no matter how the standardization is done someone will think that it is wrong. None the less, the catch rate data from the logbooks is important and a model will provide an objective means of describing the signal. It would be worth reading: Walters, C. 2003. Folly and fantasy in the analysis of spatial catch rate data. Can. J. Fish. Aquat. Sci. 60: 1433-1436.

I am a strong proponent of maintaining and using a high quality set of observer data. The authors are correct, observer data should be used to monitor fisheries, to calculate fishery induced mortality, the level and quality of discards, and to validate logbook CPUEs. I am not convinced that a well developed observer deployment and sampling program could not equally serve Science, Fisheries Management and C&P. The observers are collecting important scientific data, but this data could be used as a yardstick against which to compare the rest of the fishery. Most fishers are honest, hardworking and know that the data is being collected to ensure sustainable fisheries and therefore should be happy to have observers.

I could find no description of the trends within figure 52, the surface and density indicators for South eastern Nova Scotia. Where is this discussion?

The discussion of the Traffic light should be developed further to include the overall stock outlook, after all it was meant as a performance report.

5.1 Management considerations

5.1.1 Management areas and sub-areas. I agree with the authors that there should be no attempt to derive biomass/ abundance indices on a CFA basis. This would make no biological sense for the reasons clearly stated in the document (see section 4.6.2 Movement).

5.2.1 Spread catches over a period of years. The authors should point out that the decreased harvest scenario would be the best chance of ensuring that there are enough large males to mate with the females. It is unfortunate that we have no tools to assess risk associated with various harvest levels. Under the present circumstances it may be prudent for fishers, managers and scientists to consider decreased quotas.

I am not sure that I agree with the last paragraph in the report. How can the authors say with conviction that "Decreasing the allocation over all of the fishing grounds that have been surveyed since 2000 could slow down the decline in adult males, but will never stop it nor will it make it possible to "stabilize" the catches over the next few years." Can the authors defend this statement? Evidence to the contrary is provided in the first paragraph of the report. The resource was able to stabilize and recover from the crash in 1985.

Why do the catch rates, landings and effort trends in figures 15 and 16 differ from those presented in Appendix 3 figures 1b and 1c respectively? What new information is presented in this appendix? Where do the authors describe the Appendix 3 trends?

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Q: In the discussion section, p. 14 section 3.2.3, the mean CW for 2003 increased in CFA 20 compared to 2002. Is there a significant difference?
A: It depends on what area you are talking about, for example area 22 offshore.

Q: Would it then be possible to incorporate standard error estimates on to the associated figure 10?
A: Yes.

Q: On page 15 section 3.3.3, the data on figure 9 (ie. the seasonal average percentage of skip molters and the percentage of which were legal size) is confusing because we don't see it on the figure. Is the 11.3% referred in the text, a part of the total or only part of the proportion of skip molters?
A: It is that way. (I understood from Michel's answer that the 11.3% was part of the total.)

Q: On page 16 section 3.4, refers to a colder temperature profile on the slope of Banquerau compared to Sable Island. Would this temperature difference result in a a catchability issue for the trap survey?
A: No, I don't see it as a catchability issues, rather this is a distribution issue caused by the difference in the temperature.

Q: On page 20 section 4.2, in the observer sea sampling there is a shift in the population age. You should state that this is an older population.

A: No, this in not necessarily and indication of an older population. In ENS, there is a problem between dirty crabs and old crabs. This is representative of one area more than another. It could be the judgment of the observers. They might have been difference between a dirty crab and an old crab in this area.

(Mikio Moriyasu) There is a concentration offshore. Here there is an accelerated rate of epibionts growth and accumulation. Inshore the temperature is lower and the growth and accumulation of epibionts is slower.

Q: On page 21 section 4.4, a 3 year time series has been determined to be the minimum necessary to produce biomass index estimates with a degree of confidence. What does this imply on the Scotian shelf slope survey estimates?
A: We were asked to go back to the drawing board three years back and start from there. There are lots of crabs, but I'm not sure if it is as high as the biomass number that is given.

Q: In section 5, you have presented a brave set of conclusions and recommendations. Three final recommendations are given in section 5.2.3. The three harvest scenarios that you have outlined include increasing the TAC, keeping the status quo, and decreasing the TAC. We do not have a clear idea of what Science is recommending and what would be the goal behind such recommendations. Can you clarify what your objectives are.
A: The biomass index is decreasing, the recruitment index is decreasing, and therefore the fishery performance decreased. Under this set of observations I would not recommend increasing the allocation (TAC) or maintaining the status quo.

Q: What would be the objective of decreasing the allocation and how does this translate into levels of exploitation and TAC with the understanding that the biomass index has been recalculated for previous years?
A: To show the TAC will have to decrease because the biomass is decreasing. The TAC will increase if the status quo is continued.

(Mikio Moriyasu) Sex ratio: there are new females coming in. We do not want to decrease the number of males that will be available to mate with the females.

Marc Lanteigne
Gulf Fisheries Centre
Moncton, New Brunswick

C: You should use the exploitation rate with the trawl you use.

Q: How many crabs did you take with the tags?
A: On each tagging site we sampled between 200 and 250 crabs. We reached close to 1500 crabs.

Q: Is there a low return rate with little movement?
A: I do not know relation between the slope and the Scotian shelf.

Q: The average size in figure 10 shows there is an increase in CFA 22 offshore and an increase in CFA 24. Should you highlight something in this figure on weights?
A: There is a different equation. Condition 1 and 2 projected for year after when they will have reached full weight.

(Mikio Moriyasu) Weight and size do not correspond. Weight depends on the fullness of the meat. It could be an increase of new molters.

Q: In section 4.6.2, what is the average distance traveled?
A: The minimum and maximum are used.

Q: Is it the same in SGSL?
A: On the Scotian Shelf, I'm not sure if we can correct for poor decisions next year. There is a lot of uncertainty.

COMMENTS (C) AND QUESTIONS (Q) AND ANSWERS (A) GENERAL DISCUSSION

Paul Kehoe
Q: If there is an underestimation of the biomass, why is there no build up of carapace condition 5 crabs? What is the percentage of old crabs?
A: (Mikio Moriyasu) We cannot catch 100% of the crab therefore there is an underestimate. The old crab could be in the holes. This is due to the bottom configuration and trawl behavior. There is not the same catchability as in Area 12. I have no clear answers.

Q: There is a lot of decline. We are coming close to estimating the true biomass. If it wasn't on a decline, we would catch old crabs. I wish Science would tell us what they actually think! I am baffled with what Science thinks. We paid for science and we want the truth!
A: The biomass index is decreasing. This is clear in my mind.

(Mikio Moriyasu) We use the abundance of pigmy crab, soft-shelled crab, females, etc. as indicators as well. All I can say is there is no recommendation to increase exploitation. We cannot say to decrease because we have no real reason. With the number of people we have, we cannot do all the research needed to assess the stock. There are no studies of fecundity (number of eggs), percentage of sperm in the spermathecae (number of males). We have these studies in the SGSL, but not in ENS therefore there are limits to the ability to assess the stock.

Q: Why did Area 24A decrease by 39% in one year?
A: There was a lot of fishing pressure over the last few years in Areas 23A and 24A. It could be movement to some degree, but it is mostly fishing pressure.

Q: Could there be movement?
A: Yes, we can see from tagging. Some crabs moved into Area 23.

Q: Why did you change the survey from the spring to the fall?
A: Because the temperature is warmer in fall on the banks and also the mortality factor is easier to analyze before the fishing season. It becomes complicated to estimate fishery mortality.
C: (Mikio Moriyasu) There is a mortality of crabs of carapace condition 1 and 2 during the fishery.

Q: Are you more confident with a fall survey?
A: (Mikio Moriyasu) Yes.

Q: Where is the recruitment coming from to support area 24? From the slope?

A: (Mikio Moriyasu) Based on tagging studies, there is some indication that offshore crabs are coming inshore. Be careful, it is not unidirectional. It is based on the expansion of the biomass and when the population shrinks, the crabs go to the best habitat. It depends on the fishing effort.

Q: Is there recruitment?
A: We are currently in a period of recruitment, but it is at a low level.

Q: Will that low rate bring the population back up?
A: There will be a decrease in the biomass because of low recruitment, but we do not know how big it will become.
C: (Mikio Moriyasu) We cannot estimate what the abundance will be in 7 years.

Carl Pottie
Q: What percentage of the biomass is determined by the CPUE?
A: None.

Peter King

Q: On page 28, is this the reference for the exploitation rates? Is it mild or moderate? Is it 35% or 40%?
A: I could give you the exploitation rate from other areas, but it's not an absolute number.
C: (Mikio Moriyasu) This comes from experience in the SGSL.

David Rambeau

Q: If the trawl survey would be at the same time of the year, will the temperatures be the same too? Should we look more at temperature than actual dates?
A: If the survey is consistent, this will be one less thing to worry about. Yes, we should look at temperature too.

Q: Can temperature be superimposed from year to year?
A: Yes.

Q: Can you use "G" for green, etc. for the traffic light diagram because the document is in black and white?
A: Yes.

Q: Is the sex ratio significant?
A: (Mikio Moriyasu) Joël's model is based on females from the Bradelle Bank. You have to wait for the work to be completed.
Q: Before the seismic survey in area 18 and 19, was the biomass high?
A: (Mikio Moriyasu) Yes. It was at its highest.

Q: Will you do a survey before and after the fishery?
A: (Mikio Moriyasu) Yes, the fishermen want us to do a survey.

Q: How long does it take before the females reach a productive stage?
A: (Mikio Moriyasu) They reach maturity 4 years before the males at size 53-56 mm. One year after they moult to sexual maturity.

Q: There are no crabs in the GBH. They migrate into GBH at a high rate. Do they migrate out of GBH at the same rate?
A: They move towards the banks to fish. The distance from the hole to the banks isn't far. Seasonal migrations are faster than migrations from other areas.

Q: In ours first meetings, you said that there was not a resident crab stock in Area 20. So, why not catch it all?
A: If you fish along the Area 21 line, they won't be pleased.
C: (Mikio Moriyasu) Good question. How would this be treated by others? You will receive crabs from other areas and then you will catch it all. We don't know about reproduction. There are females there. We don't know if it would stop reproduction.

Q: Is there a difference between the Area 19 and Area 20 crab?
A: (Mikio Moriyasu) Ask the crab! No, not even genetically.

Bruce Osborne
Q: Do you have an estimate of the sex ration for ENS and the SGSL?
A: There is not one for ENS. We can only estimate it if we cover the female population.
C: (Mikio Moriyasu) There are 3 females to each male in the western side of the SGSL. On Bradelle Bank it is a ratio of 5 or 6 females to each male. In over fished areas like the Chaleur Bay and Shédiac Valley, the ratio is 2 million females to one male. This is because the exploitation rate is so high there.

Bob Anderson
Q: What are the preliminary results on snow crab from the oil and gas exploration? Is there mortality?
A: (Mikio Moriyasu) There is no immediate mortality on crab. We are looking from internal damage through EM. We are waiting to go to sea for the rest of the crab. This will finish the first phase of the project. There is no information now. It will not be finished until September. There will be a presentation in September.

Q: There are two proposals for seismic testing. Do their legs fall off and do they have dirty gills?
A: (Mikio Moriyasu) I cannot say.

Q: The hotspots of 2002 are not there now.
A: The concentrations decreased yearly because of the fishery (Area 23). There is uncertainty attached with the slope.

Appendix 1. Letter of Invitation

Gulf Region
Oceans and Science Branch
P.O. Box 5030
Moncton, NB E1C 9B6

February 23, 2004

Distribution

Subject: Peer review of snow crab stocks

You are invited to participate at the assessment of snow crab stock on the Scotian Shelf which will be reviewed at Mic Mac Amateur Aquatic Club, 192 Prince Albert Road, Dartmouth, N.S., March 23 and 24, 2004 (please see attached agenda).

This meeting will provide results of snow crab stock assessment for the northern (Areas 20, 21 and 22) and southern (Areas 23 and 24) portions of eastern Nova Scotia.

The purpose of this meeting is to conduct a thorough peer review of the stock assessment. Your participation is required to ensure that the review is of the highest quality.

Scientists will provide a brief overview of their assessments that should include the main conclusions, the supporting evidence, any new methods, and major limitations. The presentation will be followed by comments from the scientific referees and then from the invited industry participants. Unfortunately, time does not allow for contribution by observers.

Finalised stock status reports will be prepared at the meeting and the minutes of this meeting will be published as proceedings.

Région du Golfe
Direction des océans et des sciences
C.P. 5030
Moncton (N.-B.) E1C 9B6

le 23 février 2004

Liste de diffusion

Objet : Examen par les pairs des stocks de crabe des neiges

Nous vous invitons à participer à l'examen des rapports d'évaluation de stock de crabe des neiges du plateau néo-écossais qui aura lieu au Mic Mac Amateur Aquatic Club, 192 chemin Prince Albert, Dartmouth, N.-É. le 23 et 24 mars 2004 (voir l'ordre du jour ci-joint.)

Cette réunion a pour but de fournir les résultats de l'évaluation des stocks du crabe des neiges dans la région nord (zones 20, 21 et 22) et sud (zones 23 et 24) de l'est de la Nouvelle Écosse.

L'objet est de réaliser un examen exhaustif des évaluations de stock. Pour que l'examen soit de la plus haute qualité possible, votre participation est essentielle.

À la réunion, les scientifiques présenteront un résumé des résultats de leurs évaluations, qui devrait comprendre les principales conclusions, les preuves à l'appui, les nouvelles méthodes utilisées et les principales restrictions. Leur survol sera suivi d'observations des examinateurs scientifiques, puis des participants invités de l'industrie. Malheureusement, les personnes qui souhaitent participer à la réunion à titre d'observateurs n'auront pas le droit de parole.

La version finale des rapports sur l'état des stocks sera préparée à la réunion et le compte rendu de la réunion sera publié dans des procès verbaux.

We would greatly appreciate your contribution to this important exercise and look forward to seeing you in March.

Nous vous serions très reconnaissants si vous pouviez contribuer à cette activité importante. Au plaisir de vous voir en mars.

René Lavoie

Division Manager, Invertebrates
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Gestionnaire de Division, Division des Invertébrés, Région des Maritimes

cc: J. Jones
M. Chadwick
B. O'Boyle
V. Myra

Appendix 2. List of Invitees

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Appendix 4. Agenda

Peer Review of Snow Crab Stocks/
Examen par les pairs des stocks de crabe des neiges

MicMac Amateur Aquatic Club,
192 Prince Albert Road, Dartmouth, N.S. / N.-É.

March 23 - 24 / le 23 et 24 mars 2004

Proposed timetable / *Horaire proposé*

Eastern Nova Scotia / L'Est de la Nouvelle-Écosse

Tuesday, March 23 / *le mardi 23 mars*	**Time / *Horaire***	**Lead / *Responsable***
Introduction	08:30 – 09:00 hrs *de 8h30 à 9h00*	(R. Lavoie)
Environmental conditions and larval drift -- eastern Nova Scotia / *Conditions environnementales et dérive larvaire -- Est de la Nouvelle-Écosse.*	09:00 – 09:45 hrs *de 9h00 à 9h45*	J. Chassé
Health Break / *Pause-santé*	09:45 – 10:00 hrs *de 9h45 à 10h00*	
Glace Bay Hole Experiment / *Expérience Glace Bay Hole*	10:00 – 10:45 hrs *de 10h00 à 10h45*	M. Biron
Modeling uncertainties / *Incertitudes de la modélisation*	10:45 – 11:30 hrs *de 10h45 à 11h30*	E. Wade
Lunch (Buffet served at hall) / *Déjeuner (Buffet servi à la salle)*	11:30 – 1:00 hrs *de 11h30 à 13h00*	
Snow crab, Areas 20-24 -- Presentation and discussion / *Crabe des neiges, zones 20 à 24 -- Présentation et discussion*	1:00 – 3:30 hrs *de 13h00 à 15h30*	M. Biron
SSR -- Areas 20-24 / *RÉS -- zones 20 à 24*	3:30 – 4:30 hrs *de 15h30 à 16h30*	(R. Lavoie)

Wednesday, March 24 / *le mercredi 24 mars*	*Time / Horaire*	**Lead / *Responsable***
SSR -- Areas 20-24 (continuation) / *RÉS --/ zones 20 à 24 (suite)*	09:00 – 10:00 hrs *de 9h00 à 10h00*	(R. Lavoie)
Health Break / *Pause-santé*	10:00 – 10:15 hrs *de 10h00 à 10h15*	
Conclusion	10:15 – 10:30 hrs *de 10h15 à 10h30*	(R. Lavoie)
Science Mandate Transfer / *Transfert du mandat scientifique*	10:30 – 12:00 hrs *de 10h30 à 12h00*	(R. Lavoie / J. Tremblay)

Appendix 5. Meeting Remit

2004 MEETING REMIT

- Assess the status of Eastern Nova Scotia Snow Crab stocks until January 15, 2004. The assessment should include:
  - An analysis of existing fishery and survey information.
- Provide advice for the 2004 fishery.
- Provide a prognosis for the 2005 fishery
- Produce a Stock Status Report and supporting Research Document documenting the results of the assessment

DEMANDE DE RENVOI À LA RÉUNION DE 2004

- Évaluer l'état du stock de Crabe des neiges de la Nouvelle-Écosse jusqu'au 15 janvier 2004. Cette évaluation devrait comprendre :
  - une analyse des données existantes de la pêcherie et du relevé;
- Formuler des conseils sur la pêche pour l'année 2004.
- Formuler des prévisions sur la pêche pour l'année 2005
- Produire un Rapport sur l'état des stocks et le Document de recherche connexe documentant les résultats de l'évaluation.

Appendix 6. Documents Tabled and References

Document

Biron, M., L. Savoie, C. Sabean, E. Wade, M. Hébert, and M. Moriyasu, 2003. Historical review (1996–2002) and assessment of the 2003 snow crab (*Chionoecetes opilio*) fishery off eastern Nova Scotia (Areas 20 to24). CSAS Res. Doc. 2003/05 92p.

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Walters, C. 2003. Folly and fantasy in the analysis of spatial catch rate data. Can. J. Fish. Aquat. Sci. 60: 1433-1436